Chemical Characteristics of Selected Cape Breton Rivers, 1985

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June, 1987

Canadian Data Report of
Fisheries and Aquatic Sciences No. 654

Fisheries and Oceans Pêches et Océans

Canada

88-01023/

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Canadian Data Report of
Fisheries and Aquatic Sciences No.654

June, 1987

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Cat. No. Fs 97-13/0654E ISSN 0706-6465

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ABSTRACT

MacPhail, D.K., D. Ashfield and G.J. Farmer. 1987. Chemical characteristics of selected Cape Breton rivers, 1985. Can. Data Rep. Fish. Aquat. Sci. No. 654. vii + 24 p.

Chemical characteristics of 14 rivers located in the Cape Breton East management zone were measured on two occasions during 1985. Only limited information on the characteristics of these rivers previously existed, and the results of this study can be examined to aid in determining their sensitivity to acidic precipitation. In this regard, a number of Atlantic coast rivers in mainland Nova Scotia have become more acidic during at least the past 30 years, in response to increased acid loading by precipitation, and native salmon populations in some have become extinct. Salmon have been angled in all except one of the 14 study rivers during the 1980-85 period, and total catch per year in these rivers has represented from 6% to 14% of the annual totals recorded for Nova Scotia.

Key words: Atlantic salmon rivers, Cape Breton Island, Nova Scotia, water chemistry.

RÉSUMÉ

MacPhail, D.K., D Ashfield and G.J. Farmer. 1987. Chemical characteristics of selected Cape Breton rivers, 1985. Can. Data Rep. Fish. Aquat. Sci. No. 654. vii + 24 p.

En 1985, à deux reprises, on a mesuré les caractéristiques chimiques de 14 cours d'eau situés dans la zone est de gestion du Cap-Breton. On ne disposait jusqu'alors que d'une information limitée sur les caractères de ces rivières; on pourra examiner les résultats de cette étude, afin de déterminer la sensibilité de celles-ci aux précipitations acides. Dans le même ordre d'idées, un certain nombre de rivières du littoral atlantique de la péninsule de Nouvelle-Écosse sont devenues plus acides depuis au moins trente ans, en raison de l'accroissement de la charge acide introduite par les précipitations, et dans certaines, les espèces endémiques de saumons se sont éteintes. On a pêché du saumon dans 13 des 14 rivières étudiées, durant la période de l'étude (1980-1985), et le total annuel des prises y représentait 6% à 14% des totaux annuels enregistrés dans l'ensemble de la Nouvelle-Écosse.

INTRODUCTION

A number of mainland Nova Scotia rivers which drain to the Atlantic coast have become more acidic during at least the past 30 years in response to increased acid loading by precipitation (Watt et al. 1983). The most seriously acidified rivers are those found on bedrock composed of granite and/or greywacke, and in some rivers, the native populations of Atlantic salmon have become extinct. Rivers which lie on slate have higher pH values and the highest values are found for rivers which drain areas of carboniferous sediments. Watt et al. (1983) also demonstrated that the pH values of some rivers are inversely correlated with their rates of discharge, so that pH values are maximal during the late summer when discharge is lowest and minimal during the winter when discharge is usually greatest.

Previously, only limited information was available on the chemical characteristics of rivers located in Cape Breton Island. Thus, some of the chemical characteristics of 14 of these rivers were measured in 1985 during a period of high discharge and during one of low discharge. Selection of the two sampling periods was made to gain insight into the existing ranges of pH and alkalinity. The major accessible tributaries of the rivers were sampled on both occasions to provide information on the characteristics of the individual drainage areas.

A number of the study rivers lie on bedrock which belongs to the Windsor, Riversdale, Canso and Horton groups, and consists of sandstone or limestone and gypsum (Bujak and Donohoe 1980). These rivers were expected to possess significant acid-neutralizing capacity. However, other study rivers lie on granitic rocks, gneiss, schist, and bedrock belonging to the George River and Fourchu groups (Bujak and Donohoe 1980) which provide lesser amounts of acid-neutralizing capacity. Atlantic salmon were reported to have been angled in all study rivers except River Denys during the 1980-85 period (Swetnam and O'Neil 1984; O'Neil et al. 1985, 1986), suggesting that salmon populations in these rivers may not have been adversely affected by acidic precipitation.

MATERIALS AND METHODS

Sites on the Denys, Middle, Baddeck, North, Barachois, Ingonish, North Aspy, Salmon, Framboise, Grand, Tillard, and Inhabitants rivers and on the Indian and Marie Joseph brooks were visited during May and July of 1985 to obtain water samples. Samples were collected at each site in 500-mL polyethylene containers which had first been washed and then rinsed with deionized water. Samples taken for metal analyses were collected in 250-mL polyethylene containers which had been washed in a 50% HNO_3 solution and then rinsed with deionized water. Each sample for metal analysis was preserved by the addition of 1 mL of 50% HNO_3 solution. All chemical analyses of river water were performed upon return to the laboratory. A Metrohm Herisau pH meter was used to determine pH values for all sites within 24 hours of sampling. Total hardness, total alkalinity, chloride and sulfate were measured by using techniques outlined in Environment Canada (1981): total hardness as $CaCO_3$, by EDTA titration to Eriochrome Black T colour change; total alkalinity as $CaCO_3$, by potentiometric titration with H_2SO_4 to pH end points of 4.5 and 4.2; chloride, by the automated thiocyanate method; and sulfate, by titration with barium chloride, after adding thorin indicator. Specific conductance was determined at 25°C by use of a Metrohm Herisau conductivity meter and apparent colour was measured with a Helige Aqua Tester. Concentrations of calcium, magnesium and aluminum were determined by emission spectrophotometer (Jarrel-Ash, AtomComp).

For most rivers, an Ott current metre (Model C-1) was used to measure water velocity at three equally spaced positions on a line delineating the width of the river. The propeller of the metre was adjusted at each position so that measurements were made at 0.6 of total depth. Flow rate was then estimated from the equation: $R = W \cdot D \cdot V$, where:

R = flow rate or volume
W = river width
D = river depth (average of 3 measurements)
V = water velocity (average of 3 measurements)

Flow rates of the Salmon and Inhabitants rivers on the May and July sampling dates were determined by Environment Canada (1986).

ACKNOWLEDGEMENTS

We are indebted to O. Vaidya who conducted the metal analyses and to W. Horne who provided valuable assistance with the chloride determinations. Mrs. B. Field and Trudy Hart typed the manuscript and Mr. Ron MacNeil photographed the illustrations and prepared the cover artwork. K.E.H. Smith reviewed the manuscript and provided editorial comments.

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TABLE 1. Some chemical characteristics of the River Denys system during May and July, 1985[1].

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 29											
A1	Above head of tide	6.94	18.0	87.0	199	55	26.2	1.7	7.7	51.0	30
A2	Big Brook	7.15	20.5	229.0	477	30					
A3	Below River Denys Centre	6.90	18.9	56.4	148	55					
July 29											
A1	Above head of tide	7.58	50.7	212.5	471	25	82.4	4.3	13.5	142.0	40
A2	Big Brook	7.68	60.3	534.1	988	15					
A3	Below River Denys Centre	7.59	55.2	156.8	375	15					

1. No flow measurements or estimates for these sites.

TABLE 2. Some chemical characteristics of the Middle River system during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 29											
B1	Above head of tide (flow - 30.817 m^3/s)[1]	7.19	13.3	28.9	91	15	8.7	1.0	7.4	14.3	<25
B2	McKenzie Brook	7.08	9.8	22.1	76	15					
B3	Leonard McLeod Brook	7.16	10.8	28.6	85	15					
B4	McRae Brook	7.20	11.0	15.2	56	15					
B5	Above McRae Brook (flow - 12.725 m^3/s)	7.16	9.3	15.2	55	15					
July 29											
B1	Above head of tide (flow - 7.660 m^3/s)	7.48	26.2	57.8	166	10	21.5	1.9	10.1	29.0	25
B2	McKenzie Brook	7.30	18.0	43.1	127	10					
B3	Leonard McLeod Brook	7.51	22.9	44.1	166	10					
B4	McRae Brook	7.60	16.7	21.7	80	5					
B5	Above McRae Brook (flow - 3.163 m^3/s)	7.41	16.2	23.5	80	5					

1. Estimated from flow rates measured at Site B1 on July 29 and Site B5 on May 29 and July 29.

TABLE 3. Some chemical characteristics of the Baddeck River system during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 29											
C1	Above head of tide (flow - 37.198 m^3/s)[1]	7.15	9.5	30.7	91	20	10.1	0.9	6.7	18.1	< 25
C2	North Baddeck River	7.04	7.3	28.0	83	20					
C3	Above North Baddeck River (flow - 7.175 m^3/s)	6.90	5.7	11.0	41	30					
C4	Peters Brook	7.14	11.2	16.6	54	50					
July 29											
C1	Above head of tide (flow - 5.765 m^3/s)	7.49	21.9	86.2	218	15	31.8	1.8	9.0	52.0	< 25
C2	North Baddeck River	7.38	12.9	56.3	153	15					
C3	Above North Baddeck River (flow - 1.112 m^3/s)	7.48	11.7	15.2	53	20					
C4	Peters Brook	7.98	42.1	44.1	133	15					

1. Estimated from flow rates measured at Site C1 on July 29 and Site C3 on May 29 and July 29.

TABLE 4. Some chemical characteristics of the North River system during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 29											
D1	Above head of tide (flow - 18.844 m^3/s)	6.68	3.6	6.9	33	40	1.7	0.6	5.1	3.5	< 25
D2	Timber Brook	6.54	2.6	7.4	34	30					
July 29											
D1	Above head of tide (flow - 3.639 m^3/s)	7.36	8.4	11.3	48	20	3.3	0.9	5.8	2.8	60
D2	Timber Brook	7.00	6.5	10.4	44	15					

TABLE 5. Some chemical characteristics of the Barachois River system during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 31											
E1	Above head of tide (flow - 12.637 m^3/s)	6.32	2.6	6.9	35	55	1.7	0.6	5.7	2.8	60
E2	North Brook	6.57	6.9	8.3	38	30					
E3	South Brook	6.65	5.6	11.5	57	15					
July 29											
E1	Above head of tide (flow - 1.231 m^3/s)	6.99	6.4	10.4	47	20	3.1	0.9	6.5	3.2	80
E2	North Brook	6.98	6.0	11.2	46	15					
E3	South Brook	6.76	9.5	14.2	64	10					

TABLE 6. Some chemical characteristics of Indian Brook during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 30											
F1	Above head of tide (flow - 5.709 m^3/s)	6.31	2.4	6.1	31	55	1.5	0.6	5.5	3.0	<25
July 29											
F1	Above head of tide (flow - 0.837 m^3/s)	7.01	5.2	10.3	48	20	3.0	0.9	6.9	3.8	70

TABLE 7. Some chemical characteristics of the Ingonish River system during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 30											
G1	Above head of tide (flow - 6.371 m^3/s)	6.33	2.6	6.4	29	55	1.4	0.6	4.7	2.0	<25
July 30											
G1	Above head of tide (flow - 0.409 m^3/s)	7.10	11.5	15.9	60	25	4.5	1.3	6.9	4.0	60

TABLE 8. Some chemical characteristics of the North Aspy River system during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 30											
H1	Above head of tide (flow - 17.965 m^3/s)	6.65	7.1	8.6	41	50	2.1	0.7	6.4	2.7	<25
H2	Grays Hollow Brook	6.90	6.4	9.8	47	20					
H3	North Aspy River, South Branch	6.30	2.6	6.8	36	50					
H4	North Aspy River, North Branch	6.32	2.6	6.9	36	50					
July 30											
H1	Above head of tide (flow - 1.286 m^3/s)	7.40	19.7	26.0	96	15	8.5	1.9	11.3	4.9	40
H2	Grays Hollow Brook	7.20	17.0	19.6	80	10					
H3	North Aspy River, South Branch	6.89	11.8	17.2	73	15					
H4	North Aspy River, North Branch	6.99	10.6	16.2	70	15					

TABLE 9. Some chemical characteristics of the Salmon River system during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 30											
J1	Above head of tide (flow - 9.440 m^3/s)[1]	6.26	3.3	9.8	42	40	2.6	0.7	5.5	5.7	60
J2	Gaspereau River	5.82	1.1	4.7	29	45					
J3	Above Gaspereau River	6.25	4.1	11.8	48	40					
July 30											
J1	Above head of tide (flow - 1.400 m^3/s)[1]	6.52	5.0	11.3	45	60	3.3	0.8	5.9	4.3	110
J2	Gaspereau River	6.00	2.2	5.9	33	40					
J3	Above Gaspereau River	6.58	5.7	12.7	47	65					

1. Gauging station 01FJ001 (Environment Canada 1986).

TABLE 10. Some chemical characteristics of the Framboise River system during May and July, 1985.[1]

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 30											
K1	Bagnells River	6.53	2.6	6.9	35	25	No data				
K2	Middle River Framboise	6.23	1.5	5.2	28	50					
K3	Northeast Framboise River	6.18	1.6	5.9	33	50					
July 30											
K1	Bagnells River	6.75	5.0	9.1	39	40					
K2	Middle River Framboise	6.56	2.7	6.1	31	55					
K3	Northeast Framboise River	6.50	2.3	6.7	35	60					

1. No flow measurements or estimates for these sites.

TABLE 11. Some chemical characteristics of Marie Joseph Brook during May and July, 1985.[1]

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 30											
L1	West Branch, Marie Joseph Brook	6.52	3.6	7.8	37	55	No data				
L2	MacCormicks Brook	6.40	2.5	5.9	31	45					
L3	Marie Joseph Brook	6.55	3.0	7.2	35	25					
July 30											
L1	West Branch, Marie Joseph Brook	6.93	8.8	12.1	49	55					
L2	MacCormicks Brook	6.82	6.4	8.8	40	50					
L3	Marie Joseph Brook	6.86	6.4	9.3	41	40					

1. No flow measurements or estimates for these sites.

TABLE 12. Some chemical characteristics of the Grand River system during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 31											
M1	Above head of tide (flow - 5.391 m^3/s)	6.79	4.9	14.0	52	20	4.2	0.8	5.6	8.1	<25
M2	Murchison Brook	6.87	7.0	12.0	49	25					
M3	Outflow from Barren Lake	6.28	2.3	5.9	32	40					
M4	Outflow from Loch Lomond	6.76	4.7	15.2	52	15					
M5	Black River	6.78	7.5	12.3	49	30					
July 30											
M1	Above head of tide (flow - 2.713 m^3/s)	7.00	5.1	14.7	54	20	5.1	1.0	5.4	8.4	80
M2	Murchison Brook	6.93	12.0	16.7	61	20					
M3	Outflow from Barren Lake	6.52	3.6	6.9	34	25					
M4	Outflow from Loch Lomond	6.89	7.5	15.3	53	15					
M5	Black River	6.98	9.8	14.7	52	55					

TABLE 13. Some chemical characteristics of the River Tillard system during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 31											
N1	Above head of tide (flow - 1.627 m^3/s)	6.40	3.4	10.6	66	55	2.8	0.7	11.6	6.9	70
N2	East River Tillard	6.53	4.4	14.9	98	55					
N3	Below Hill Lake	6.10	1.3	5.4	31	50					
July 31											
N1	Above head of tide (flow - 0.476 m^3/s)	6.66	6.7	15.2	102	50	4.7	1.2	17.3	9.9	100
N2	East River Tillard	6.92	9.2	26.0	166	50					
N3	Below Hill Lake	6.30	2.8	6.5	35	50					

TABLE 14. Some chemical characteristics of the River Inhabitants system during May and July, 1985.

Site	Site name	pH	Total alkalinity (mg/L)	Total hardness (mg/L)	Specific conductance (µS/cm)	Apparent colour (relative units)	Ca	Mg	Cl	SO_4	Al (µg/L)
							(mg/L)				
May 31											
P1	Above head of tide	6.96	16.8	48.0	270	55	15.0	1.5	48.6	31.5	<25
P2	Above MacDonalds Brook (flow - 4.360 m^3/s)[1]	7.04	18.5	37.4	230	55	11.1	1.6	40.5	17.5	<25
P3	Northwest Arm at Askilton	7.27	20.6	170.3	710	30			72.9	123.0	
P4	Northwest Arm below Brown Brook	6.84	7.5	13.4	51	60					
P5	Lamey Brook at Queensville	7.42	21.6	26.3	88	30					
July 31											
P1	Above head of tide	7.35	32.5	100.0	593	25	39.2	3.2	113.4	52.0	100
P2	Above MacDonalds Brook (flow - 1.020 m^3/s)[1]	7.44	34.2	86.2	562	20	33.9	2.8	113.4	52.5	90
P3	Northwest Arm at Askilton	7.46	40.2	289.1	1,414	15	117.0	3.6	283.5	198.0	<25
P4	Northwest Arm below Brown Brook	7.75	27.7	31.2	93	15					
P5	Lamey Brook at Queensville	7.69	39.8	40.2	133	20					

1. Gauging Station 01FA001 (Environment Canada 1986).

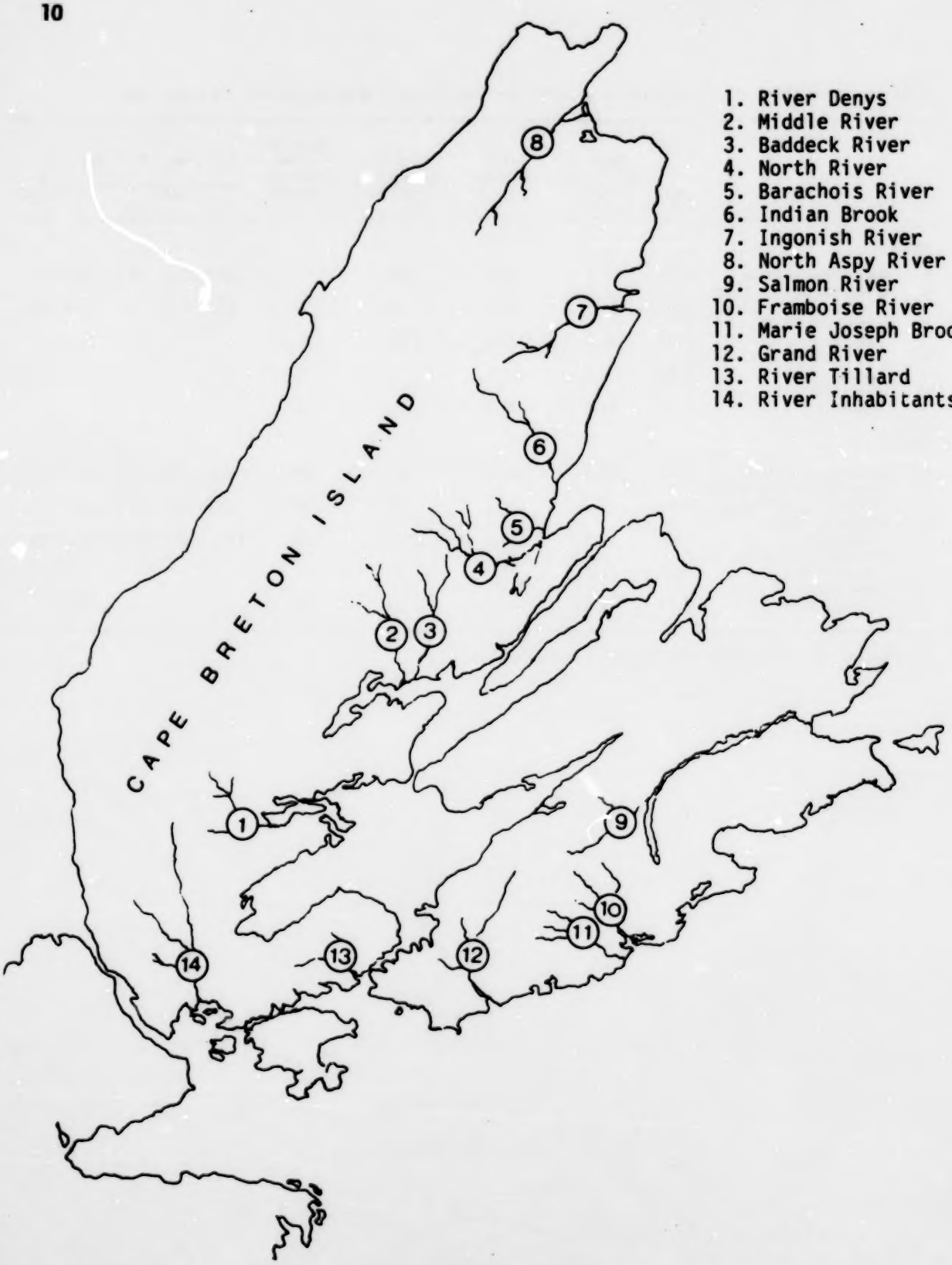

FIG. 1. Location of rivers included in the sampling program.

FIG. 2. Water sampling sites on River Denys.

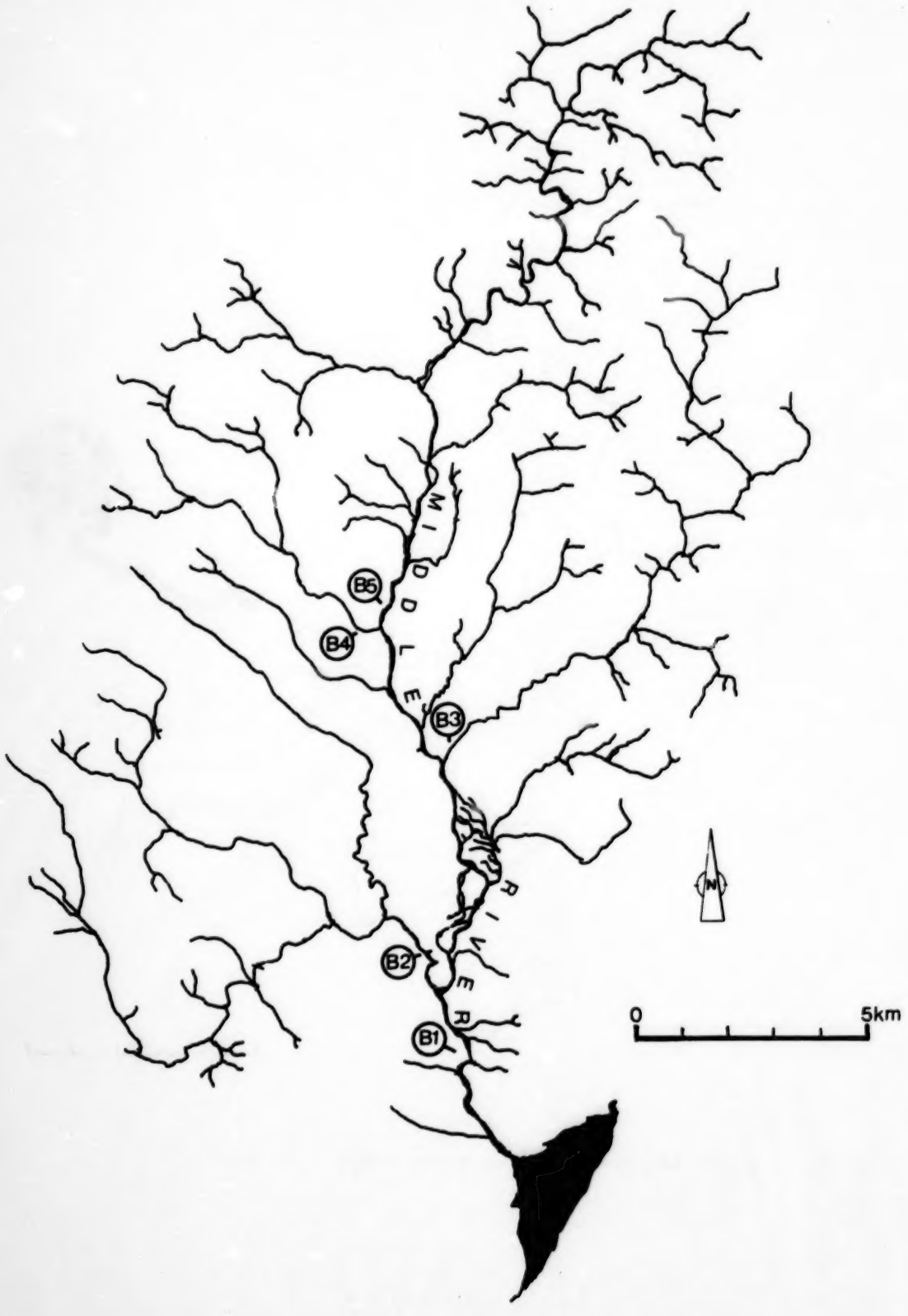

FIG. 3. Water sampling sites on Middle River.

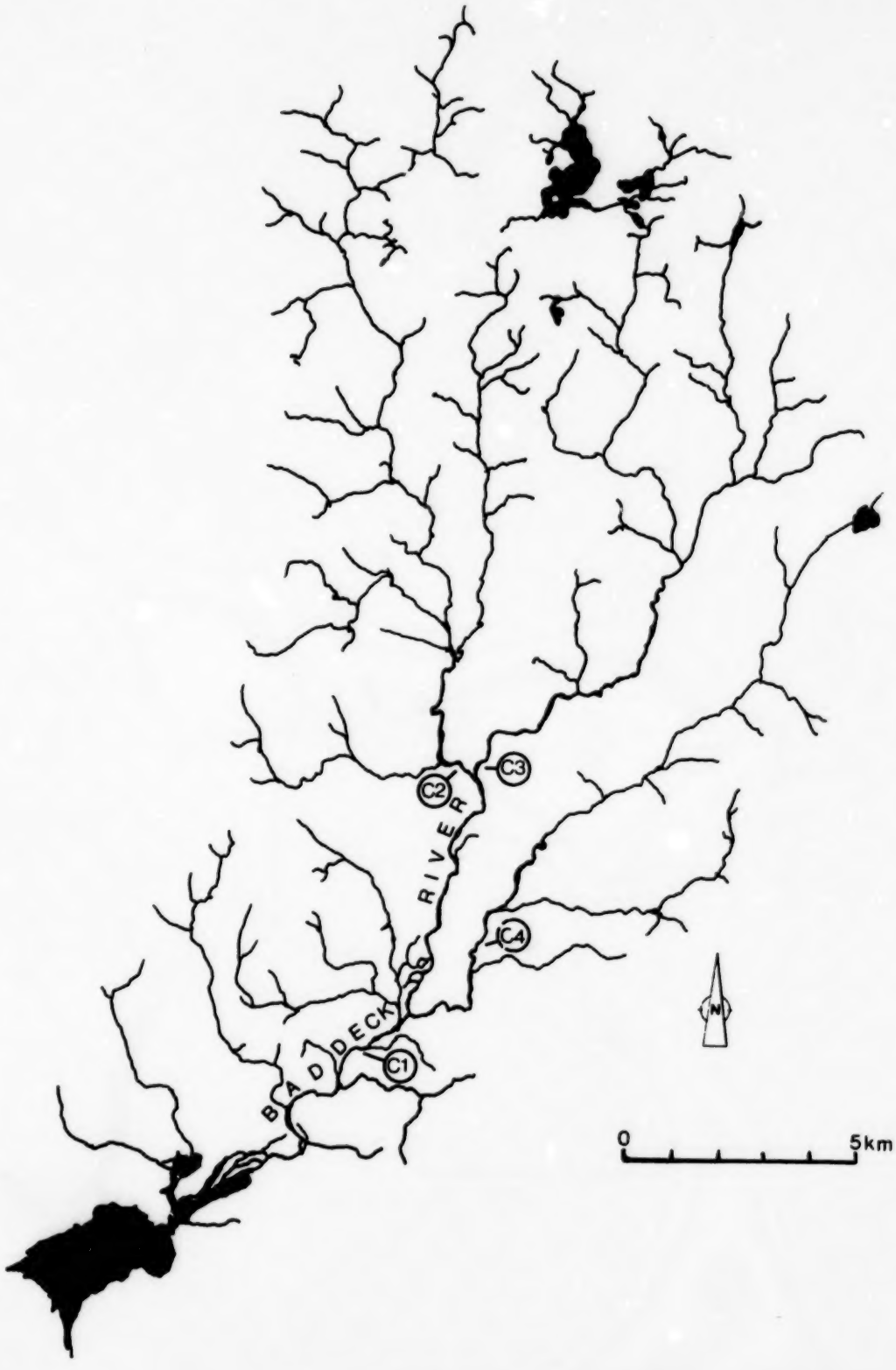

FIG. 4. Water sampling sites on Baddeck River.

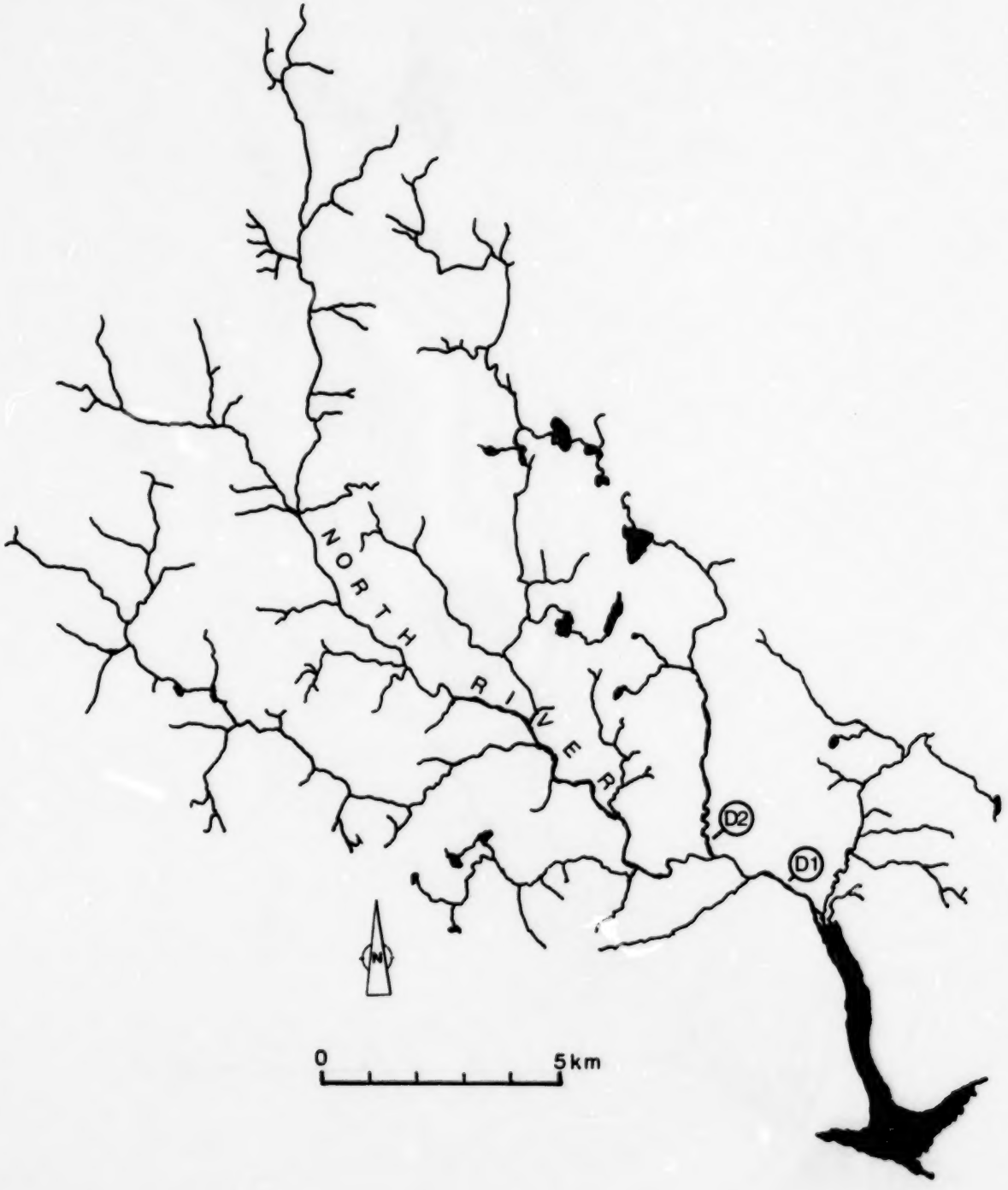

FIG. 5. Water sampling sites on North River.

FIG. 6. Water sampling sites on Barachois River.

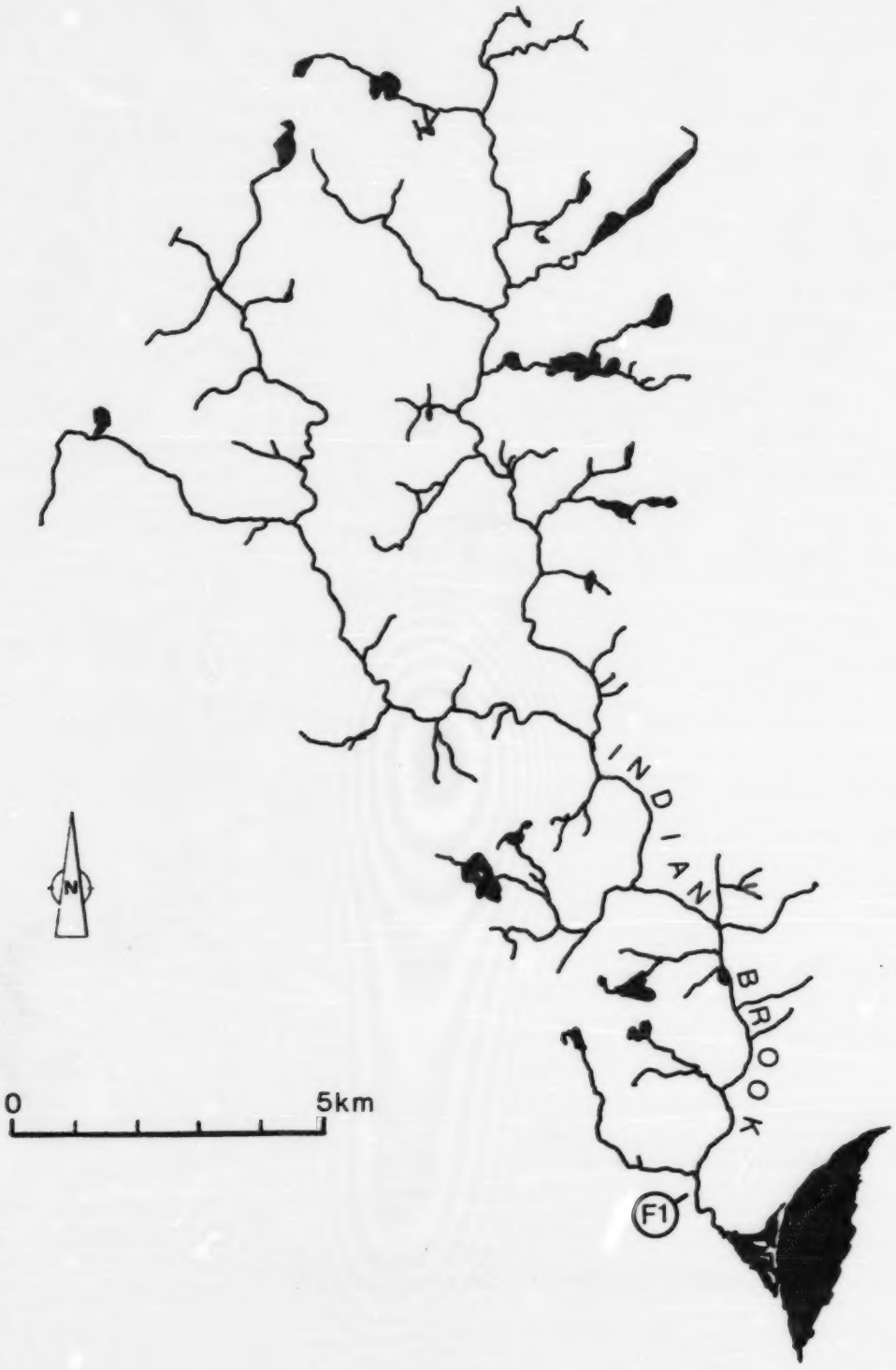

FIG. 7. Water sampling site on Indian Brook.

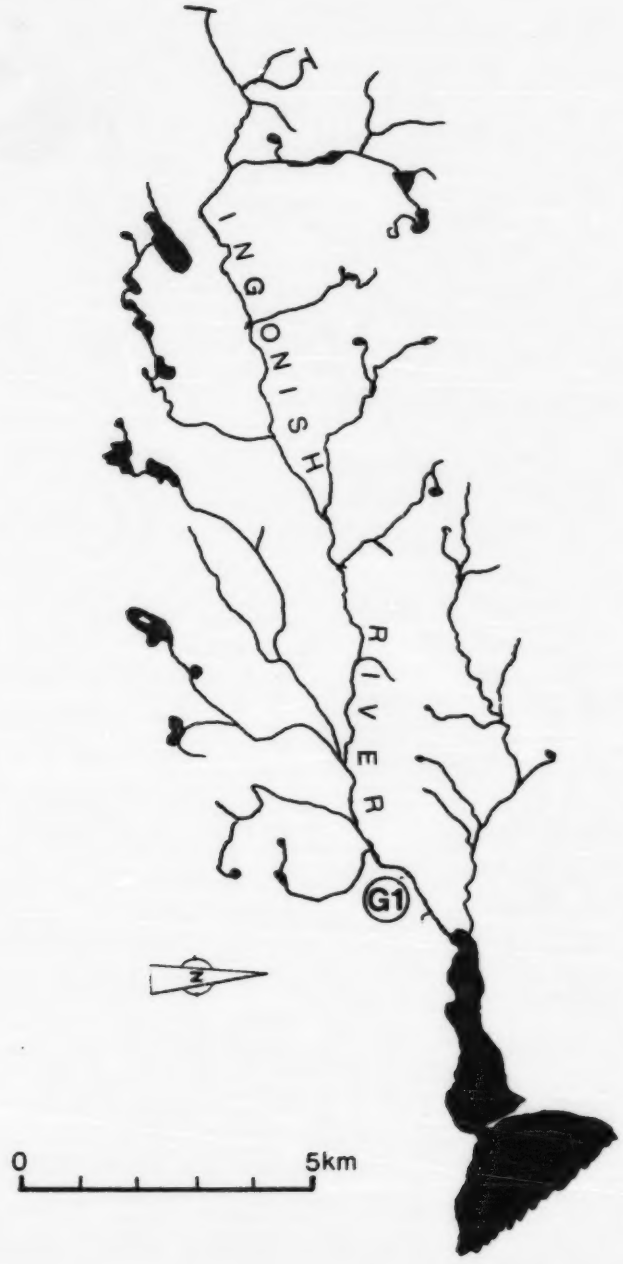

FIG. 8. Water sampling site on Ingonish River.

FIG. 9. Water sampling sites on North Aspy River.

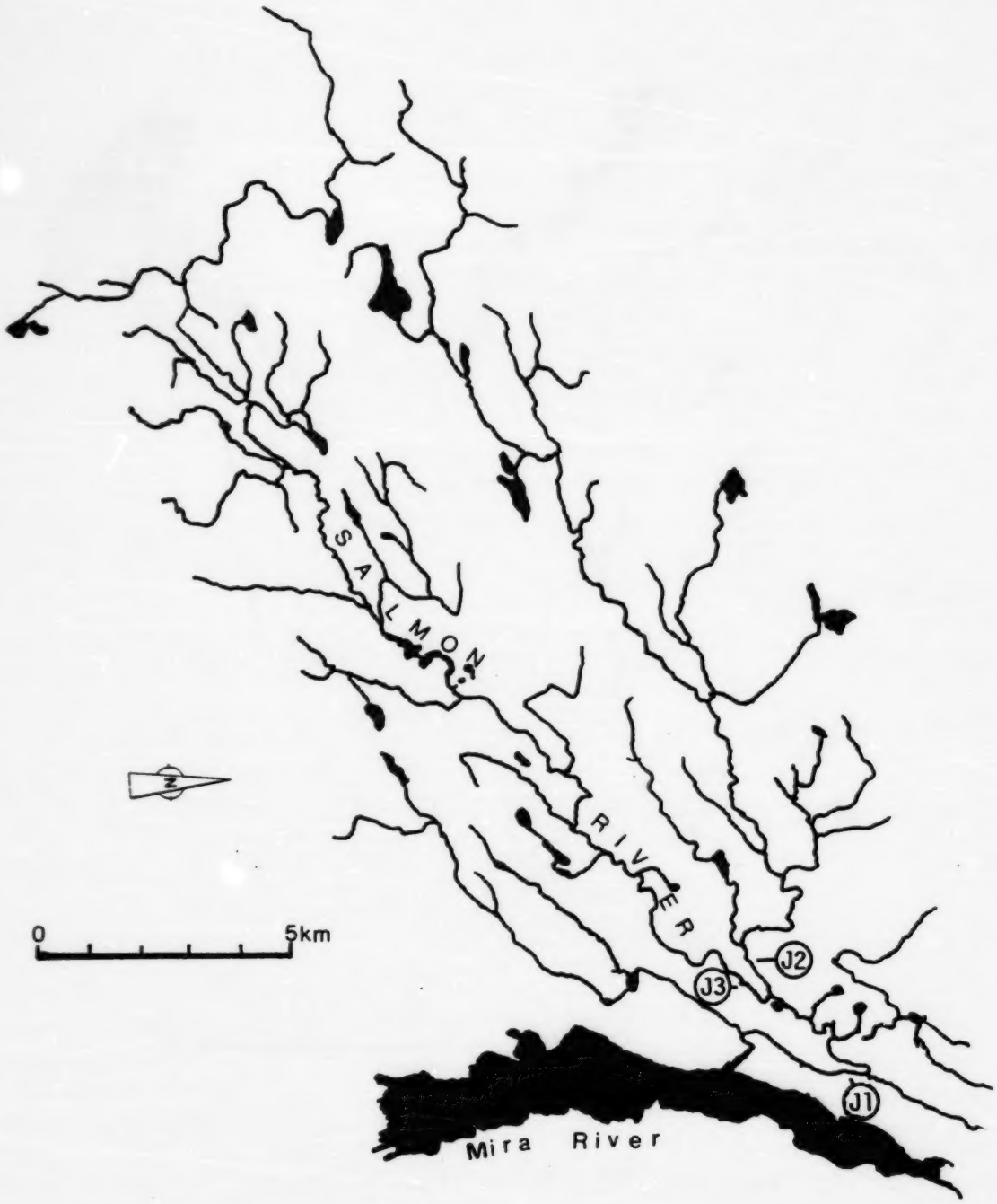

FIG. 10. Water sampling sites on Salmom River.

FIG. 11. Water sampling sites on Framboise River.

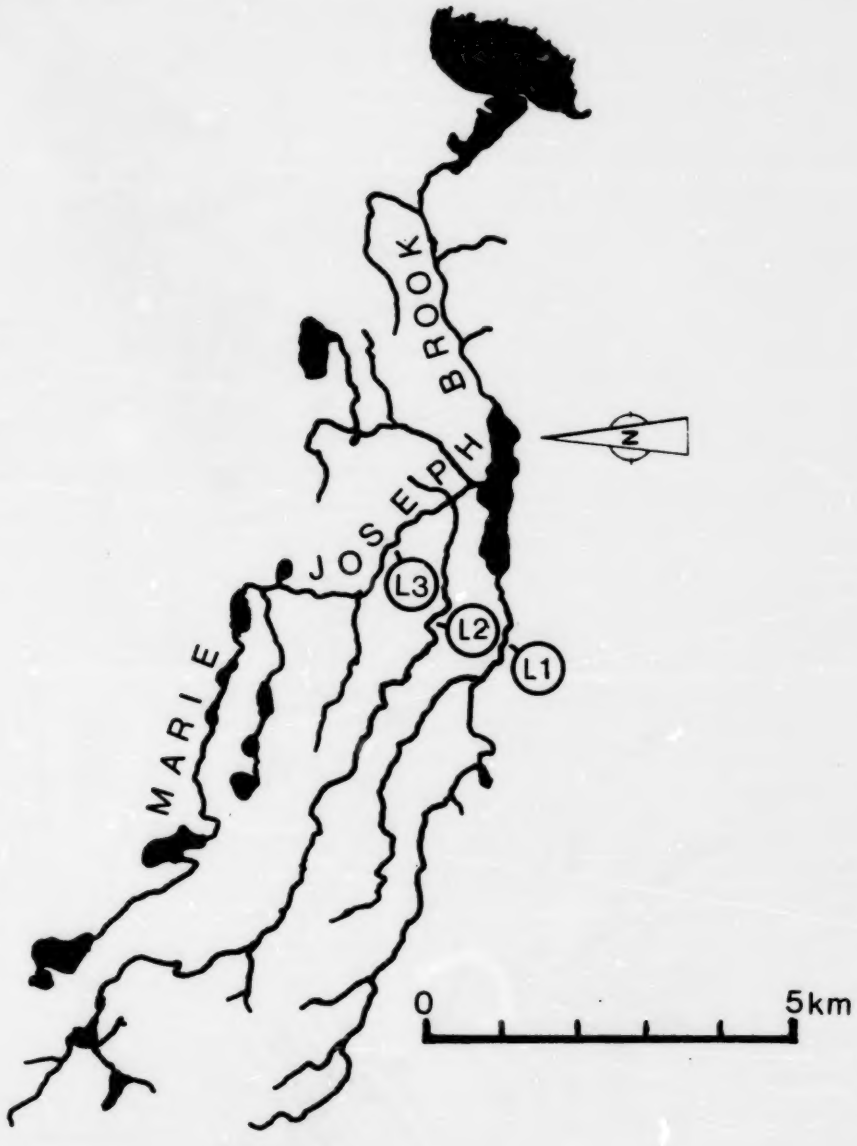

FIG. 12. Water sampling sites on Marie Joseph Brook.

FIG. 13. Water sampling sites on Grand River.

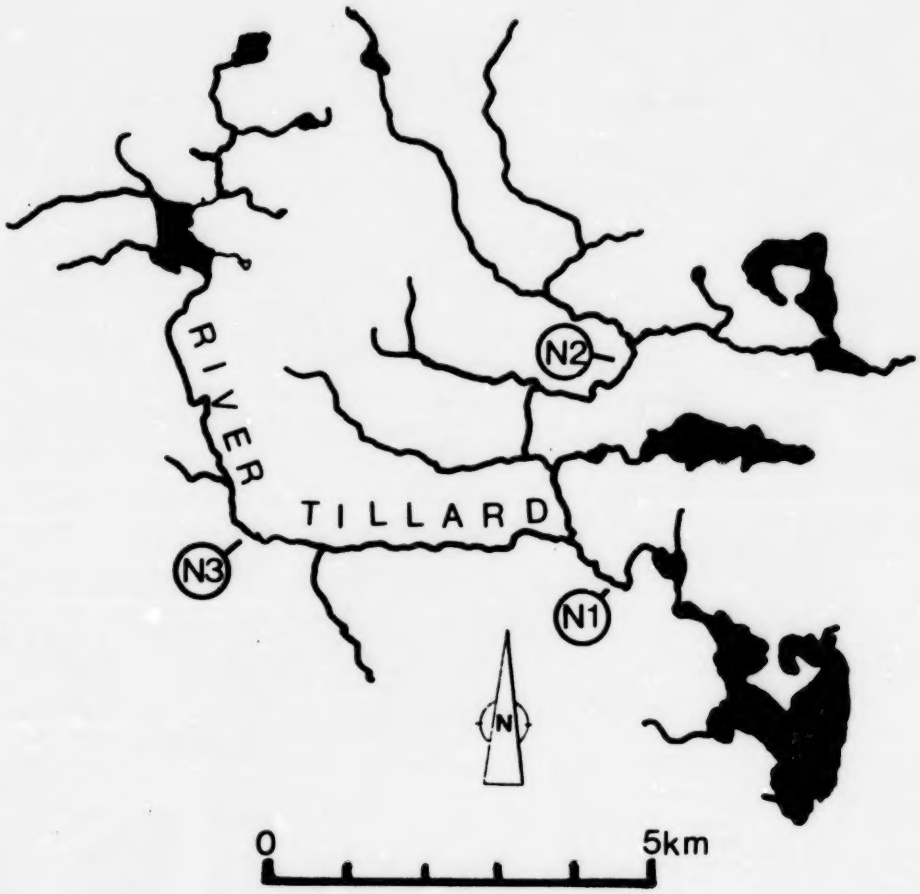

FIG. 14. Water sampling sites on River Tillard.

FIG. 15. Water sampling sites on River Inhabitants.